Native grassland at Safety Beach, Mornington Peninsula, Victoria

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Abstract
Small patches of remnant vegetation at Safety Beach, on the Mornington Peninsula, are described. Floristic and historical evidence are examined, in an attempt to reconstruct the vegetation of this area before colonisation. There is strong evidence that the plains between the slopes of Mt Martha and Arthurs Seat once supported patches of seasonally 'boggy' natural grassland sparsely timbered with Blackwood *Acacia melanoxylon*. The plain also supported patches of Swamp Paperbark *Melaleuca ericifolia* scrub, and numerous wetlands. Previous mapping exercises have not identified grasslands on the Mornington Peninsula. The observations presented here add to a growing awareness that patches of grassland were once scattered through low-lying areas of South Gippsland. The ecology of these areas is discussed, along with the prospects for their conservation on the Mornington Peninsula. This paper records the presence of several significant plant taxa, including Golden Cowslips *Diuris behrii* (vulnerable in Victoria) and Purple Blown-grass *Lachnagrostis punicea* subsp. *punicea* (rare in Victoria). (*The Victorian Naturalist* **124** (3), 2007, 132-149)

Introduction

Safety Beach occupies the coastal flat between the prominent granitic hills of Arthurs Seat and Mt Martha, on the Mornington Peninsula (Gippsland Plain Bioregion). The low, near-coastal land surface is composed largely of heavy, dark-coloured clays, derived from Quaternary swamp and stream deposits. In places, low prominences of sand and gravel occur. The plain extends eastward over a kilometre inland, before the land surface gently rises at the commencement of the 'Baxter sandstone', which extends across much of the northern half of the Mornington Peninsula (Geological Survey of Victoria, 1967a,b).

Safety Beach has been largely urbanised for many years; however, on several 'vacant' blocks, remnant native vegetation has survived. This vegetation is increasingly under threat of destruction. Some was destroyed in ~2004 with the construction of the new Mt Martha Marina, while other patches were developed for housing between 2000 and 2007.

During a recent project undertaken for the Mornington Peninsula Shire (Sinclair *et al.*, 2006) it was necessary to map all native vegetation on the Mornington Peninsula at a scale which captured these remnant patches (1:10,000). It was evident that previous studies had not adequately considered the vegetation of Safety Beach, neither as it appears today, nor how it was before urbanisation. Calder (1972, 1974, 1975), in her studies of vegetation across the Mornington Peninsula, makes little mention of the area, but suggests that the low-lying flat was once a large scrub of Swamp Paperbark *Melaleuca ericifolia*. The available broad-scale (1:100 000) representation of the deduced pre-1750 vegetation (Department of Sustainability and Environment (DSE) 2001a) did not make specific allowance for this heavy-soil flat. Instead, the area is represented as a transitional zone between Coast Banksia Woodland (Ecological Vegetation Class (EVC) 2, see Table 1) and Grassy Woodland (EVC 175, which occurs on the Baxter Sandstone and the granitic areas; see Table 1). Even cursory examination confirms that the remnant vegetation present at Safety Beach is markedly different from either of these vegetation types. The most recent mapping of current vegetation did not capture these remnant areas at all, due to the broader scale of this mapping (1:25,000) (DSE 2001b; Oates and Taranto, 2001).

Detailed investigation of the flora of Safety Beach was thought warranted now, since future opportunities for understanding the natural vegetation of this area will become increasingly limited as urban

development proceeds. This project used information from historical survey maps and old aerial photographs along with detailed field investigations in an attempt to reconstruct former natural vegetation patterns. This approach has been very useful in other studies aimed at reconstructing native vegetation in long-modified areas of lowland southern Victoria (e.g. Lunt 1997; Cook and Yugovic 2003; Yugovic and Mitchell 2006).

Methods

Historical Information and GIS work

Historical survey plans (drawn between 1803 and 1857, Results and Reference sections) of Safety Beach were viewed on microfilm at the State Library of Victoria. Aerial photographs taken before urbanisation were also consulted (State Rivers and Water Supply Commission, State Aerial Survey of Victoria. Photographs prepared by Department of Lands and Survey from photographs taken on 12 January 1957. Sheets: Westernport A1, A3; Sorrento B4). These historical sources were examined alongside modern GIS (geographical information system, Arcview 3.2.) data, provided by DSE, including hydrological, topographic and cadastral features; and soil maps (Geological Survey of Victoria, 1967a,b). Where necessary, aerial photographs and images of the historic plans were scanned and introduced into a GIS environment using 'ImageWarp' to georeference the images.

Field examinations

The remnant vegetation at Safety Beach is often treeless, and not easily detected on aerial photographs. Every street in Safety Beach was travelled, and all 'vacant' house blocks were briefly examined from the road. Over 50 were found to contain some native vegetation. Most of these areas were on private land. These were examined closely where it was clear that public entry was frequent and/or unhindered, while those blocks which were fenced were not examined. Most blocks contained few native species in low abundance, and were not investigated in detail. Twenty-seven accessible sites were identified that were considered to be informative in reconstructing the pre-settlement flora. At ten of these sites, quadrats were taken. These data are held in DSE's Flora Information System (FIS) (quadrats E03403-E03412).

Vegetation description

Victoria's DSE currently uses EVCs to describe native vegetation. This typology is employed in this report. All EVCs mentioned in the text are summarised in Table 1. For clarity, however, the specific vegetation patterns of Safety Beach are generally described here in as much detail as possible without reliance on the EVC typology.

Results

Historical information

Due to its position on the coast of Port Phillip, Safety Beach is well represented on early Victorian survey maps. The earliest maps of the area that make reference to its vegetation were drawn well before extensive settlement of the area, although they provide few annotations of ecological interest. Charles Grimes, who explored Port Phillip in 1802, simply labels the area between Arthurs Seat and Mt Martha as 'Swamp' (Grimes, 1803). Tuckey (1804) provides a slightly more detailed rendering of the vegetation, and delineates a crescent-shaped area extending along the coast and about a kilometre inland, and labels it 'extensive swamp'. Further inland, at the base of Mt Martha, Tuckey draws a 'large lagoon'. Cross (1827), shows three small creeks, and again labels the area as 'swampy'.

The first detailed survey of the area was made in 1841 by Thomas Nutt, for the squatter Hugh Jamieson, who took up one of the first runs on the Peninsula. The boundary of Nutt's survey was marked with blazed trees, and these boundaries are faithfully retained in today's property and infrastructure layout. The certainty with which these bounds can be recognised today, along with the sketched courses of some creeks, allow the annotations on vegetation to be accurately positioned in discrete portions of the landscape. Along the coast, Nutt (1841) shows a narrow 'Sandy Beach', with a 'swampy flat' immediately inland, marked with small dots and sketches of tussocks. This area is drained by three small creeks, one of which (Brokil Ck (or Tassel Ck)) is labelled 'salt water'. Further inland, he records a 'Fine Flat',

Table 1. Summary descriptions of EVCs mentioned in this report. Further information can be found, as indicated, in the following sources: 1: Oates and Taranto (2001), 2:Yugovic (unpubl.), 3: Frood (unpubl.), 4: Frood (1991).

EVC	Environment/ soil	Prominent Species locally (examples only)	Structure	Ref.
2 Coast Banksia Woodland	Deep sands near coast, often sheltered from wind and fire	*Banksia integrifolia*, *Leucopogon virgatus*, *Tetragona implexicoma*, *Rhagodia candolleana*, *Pteridium esculentum*, *Lepidosperma gladiatum*	Woodland to 20m	1,2
3 Damp-sands Herb-rich Woodland	Undulating sandy country, usually relatively fertile	*Eucalyptus viminalis*, *Eucalyptus radiata*, *Acacia mearnsii*, *Acacia melanoxylon*, *Leptospermum continentale*, *Bossiaea cinerea*, *Amperea xiphoclada*, *Lomandra longifolia*, *Pteridium esculentum*	Woodland or forest to 20m	1,2
9 Coastal Saltmarsh	Soils waterlogged and periodically inundated by saline water	*Sarcocornia quinqueflora*, *Suaeda australis*, *Samolus repens*, *Juncus kraussii*, *Gahnia filum*, *Distichlis distichophylla*	Herbland or shrubland to 1.5m	1,2,3
10 Estuarine Wetland	Soils waterlogged and almost permanently inundated by saline water	*Juncus kraussii*	Sedgeland or herbland to 1.5m	3
13 Brackish Sedgeland	Various soils waterlogged by saline water	*Gahnia trifida*, *Gahnia filum* (unknown - virtually extinct locally?)	Sedgeland to 2m	3
53_61 Swamp Scrub (Freshwater)	Damp, relatively fertile flats, occasionally flooded or waterlogged	*Melaleuca ericifolia*, *Acacia verticillata*, *Senecio minimus*, *Acaena novae-zelandiae* *Poa* spp., *Microlaena stipoides*, *Juncus* spp., *Gahnia* spp., *Carex appressa*.	scrub to 5m	1,2,3
53_62 Swamp Scrub (Estuarine)	Damp, sheltered margins of estuaries and saltmarshes	*Melaleuca ericifolia*, *Poa labillardierei*, *Suaeda australis*, *Gahnia filun*	Scrub to 5m	1,3
83 Swampy Riparian Woodland	Streambanks on flats and in low gradient gullies	*Eucalyptus ovata*, *Acacia melanoxylon*, *Melaleuca ericifolia*, *Lomandra longifolia*, *Goodenia ovata*, *Phragmites australis*	Woodland to 20m	1,3

Table 1. Cont.

125 Plains Grassy Wetland	Shallow (often closed) depressions on heavy soils, seasonally inundated by shallow standing freshwater	*Poa labillardierei*, *Amphibromus* spp., *Lachnagrostis* spp., *Notodanthonia semiannularis*, *Epilobium billardierianum*, *Eleocharis acuta*, *Eryngium vesiculosum*	Grassland or herbland to 1m	1,2,3
132_06 Plains Grassland (South Gippsland)	Heavy-soil flats, seasonally waterlogged	See main text	Grassland to 1m	2,3,4
175 Grassy Woodland	Various. Relatively fertile soils, often with freely-draining material overlying clay	*Eucalyptus viminalis*, *Eucalyptus ovata*, *Eucalyptus pauciflora*, *Eucalyptus radiata*, *Allocasuarina* spp., *Banksia marginata* (tree-form), *Exocarpos cupressiformis*, *Leptospermum continentale*, *Gahnia radula*, numerous herbs and grass-like plants	Woodland to 20m	1,2
710 Damp Heathland	Poorly drained, infertile sites, often with underlying clays impeding winter drainage	*Leptospermum continentale*, *Allocasuarina paludosa*, *Banksia marginata* (shrub form), *Gahnia radula*	Heathland to 2m	1,2
793 Damp Heathy Woodland	Poorly drained, infertile sites, often with underlying clays impeding winter drainage	*Eucalyptus cephalocarpa*, *Eucalyptus ovata*, understorey as above (710)	Sparse woodland to 15m	1,2
914 Estuarine Flats Grassland	Heavy-soil flats, usually associated with estuaries, often waterlogged by saline and/or fresh water	*Poa labillardierei*, *Poa poiformis*, *Juncus kraussii*, *Phragmites australis*, *Distichlis distichophylla*, *Samolus repens*. *Acaena novae-zelandiae*	Grassland to 1m	1,2,3
934 Brackish Grassland	Heavy-soil flats, occasionally waterlogged, some saline influence	*Poa labillardierei*, *Poa poiformis*, *Calocephalus lacteus*	Grassland to 1m	1,2,3
937 Swampy Woodland	Seasonally waterlogged flats	*Eucalyptus ovata*, *Acacia melanoxylon*, *Melaleuca ericifolia*, *Goodenia ovata*, *Carex appressa*, *Poa labillardierei*, *Poa tenera*, *Gahnia* spp., *Centella cordifolia* and other inundation tolerant herbs and grasses	Woodland to 20m	1,2,3

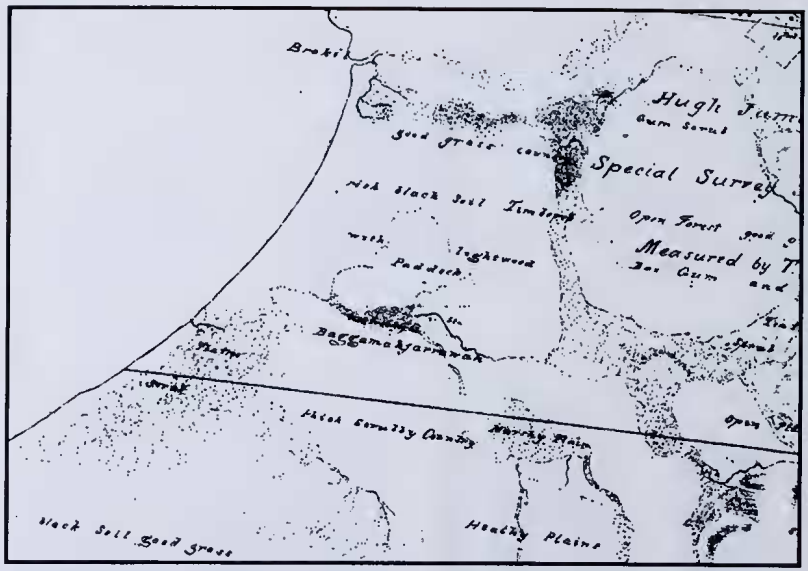

Fig 1. The survey plan of Smythe (undated). The text on this image has been sharpened by hand. This is one of two near-identical hand-drawn plans, both of which were used in composite. The word 'Baggamanjarrawah' (or 'Baggamahjarrawah') is of unknown significance, but may be a place name. The dotted line around the word 'paddock' roughly corresponds to the mapped sandy rises, (see Fig. 2) but probably shows only a fence line, and may not correspond to any natural feature.

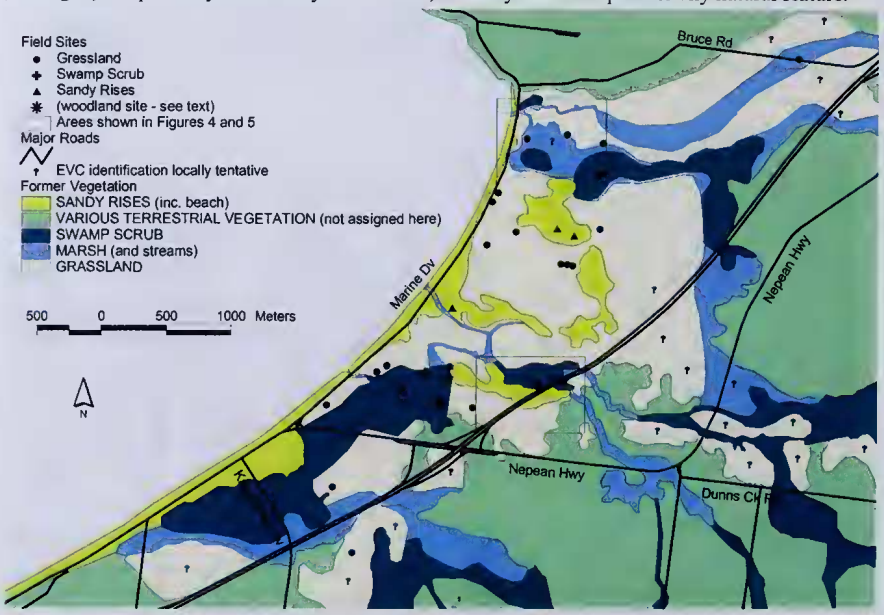

Fig. 2. The deduced pre-settlement patterns of native vegetation present at Safety Beach. The twenty -seven field sites examined during this study are marked on the map, assigned to different vegetation types. These include the 10 quadrats, for which the precise location details are held by the author and in the FIS database. Major roads are also shown for the purpose of orientation. Figs 1 and 2 are presented in the same orientation (but are cropped slightly differently to better include certain details). The sloping line on Fig. 1 represents the edge of Nutt's (1841) earlier survey, and this line is retained exactly in the present alignments of Nepean Hwy and Dunns Ck Rd. Mt Martha is immediately north, and Arthurs Seat immediately south, of both Figs. 1 and 2.

Fig. 3.. Grassland at Safety Beach. The grass sward at one relatively high-quality site (FIS Quadrat E03403) is shown. The letter (d) shows the most conspicuous example in the photograph of a gilgai depression, supporting Coast Tussock-grass and Prickfoot, and the lower letter (r) shows a raised area, supporting Kangaroo Grass, as discussed in the text.

with areas of 'Tea Tree Scrub' flanking it to the north and south. This 'Fine Flat' is located coast-ward of the present-day Moorooduc Hwy. Further inland, Nutt records various areas of 'Swampy' land, forests and woodlands.

The Crown Lands Office produced another detailed map in 1857 (Anon. 1857). This map shows the boundary of Nutt's previous survey, and represents the infrastructure then present. The near-coastal flat is again labelled 'swampy flat' and marked with lines of dots. The inland side of this flat is flanked by an area labelled 'Tea tree scrub'. It is bounded to the north on the lower slopes of Mt Martha by a 'fine flat moderately timbered with Honeysuckle [probably tree form *Banksia marginata*]' and to the south near Arthurs Seat by a 'sandy rise' and an area 'thickly wooded' with 'Oak [*Allocasuarina* spp.] and Honeysuckle'. Near the coast, at the junction of Nepean Hwy and Dromana Pde, an un-annotated area (now urbanised) is densely stippled, and possibly represents a wetland or scrub.

The most informative early map is an undated map drawn by George Smythe (Fig. 1). It shows the boundary of Nutt's pre-existing survey (1841), but shows less developed infrastructure than in 1857, suggesting that it was surveyed between 1841 and 1857. On this map, comments on the vegetation relate to clearly defined areas. Patches of 'Tea Tree Scrub' and 'Marshy Plains' are shown with detailed boundaries. Given the great precision with which the courses of all the creeks are plotted across the Peninsula, as seen when Smythe's plan is aligned to modern GIS layers, these boundaries are likely to be reliable.

All the maps agree in the basic layout of the vegetation at Safety Beach, allowing the information to be brought together into a coherent whole. Behind the narrow sandy coastal strand, on the heavy clay soils, extending about a kilometre inland and covering several hundred hectares, was a 'flat', variously represented as being 'swampy', 'fine' or 'grassy', and clearly distinct from areas of 'tea tree scrub'. Smythe describes this area as being 'rich black soil timbered with lightwood' (discussed below), while no other reference is made to trees or shrubs on this area. Three or four small creeks entered Port Phillip from this flat, at least one of which (Brokil Creek) was brackish. All around this flat were areas of 'tea tree scrub' along drainage lines, and further areas of 'marsh'. Further inland (roughly beyond the Mornington Peninsula Freeway, north of Bruce Rd and south of Nepean Hwy, see Figs 1 and 2) vegetation descriptions mostly relate to woodlands and scrubs, remnants of which persist in various condition states across the Peninsula, while most of the 'flat' has been cleared. The focus of this paper is the original vegetation of the 'flat' (Figs 1 and 2), which remains undocumented.

Given these descriptions and its position in the landscape, the 'flat' probably supported vegetation referrable to Plains Grassland (South Gippsland) (EVC 132_62) and/or Brackish Grassland (EVC 934) along with Plains Grassy Wetland (EVC 125, in the broad sense) (Frood, 1991; Oates and Taranto, 2001). Such grassland communi-

tics have not been previously mapped on the Mornington Peninsula, and will be the focus of this paper.

Vegetation of the coastal flat at Safety Beach – past and present

Among the 22 sites examined in detail, areas representative of several distinct vegetation types were found, corresponding closely to the vegetation described in the historical record. As described below, each of these is generally assignable to one or more EVCs. Table 2 presents species lists for the these mapped 'zones'. These lists are each derived from several sites examined within each zone, shown on Fig. 2.

Grassland

Fourteen sites support native grasslands, on heavy soils with an undulating or 'gilgai' surface that tends to be waterlogged in winter and deeply cracking in summer. Across most of the sites investigated (FIS quadrats E03403-E03408), the native graminoid layer is dominated by a combination of Coast Tussock-grass *Poa poiformis* (discussed below), Wetland Wallaby-grass *Notodanthonia semiannularis*, and Kangaroo Grass *Themeda triandra*. Even in the small remaining patches, the floristic composition varies notably at a fine spatial scale (several metres). This variation seems to be determined largely by surface microtopography. Fig. 3 shows the grass sward at the largest remaining site at Safety Beach. The labels show a raised area (gilgai 'puff') and a slight gilgai depression. On the raised area, Kangaroo Grass dominates strongly, and is accompanied by other species usually found in drier habitats, including Creeping Bossiaea *Bossiaea prostrata* and Cranberry Heath *Astroloma humifusum*. In the depression, Coast Tussock-grass and Wetland Wallaby-grass dominate, along with several herbs tolerant of seasonal waterlogging, such as Prickfoot *Eryngium vesiculosum* and Pennywort *Centella cordifolia*. As discussed below, some of these low-lying areas approach wetlands in their ecology and composition.

Despite weed invasion, many native species in addition to those noted are relatively common throughout these grassland patches, including Mat Grass *Hemarthria uncinata* Common Bog-rush *Scheonus apogon*, and the herbs Slender Speedwell *Veronica gracilis*, Milky Beauty-heads *Calocephalus lacteus*, Wiry Buttons *Leptorhynchos tennifolius*, Varied Raspwort *Haloragis heterophylla*, Small Loosestrife *Lythrum hyssopifolia*, Wood-sorrel *Oxalis* sp aff. *exilis* (glabrescent), and Tall Sundew *Drosera peltata* subsp. *peltata*. Shrubs are rare, the most common being Hop Goodenia *Goodenia ovata* and Swamp Paperbark *Melaleuca ericifolia*.

According to the present EVC typology, these areas are accommodated largely within the broad conception of Plains Grassland (South Gippsland) (EVC 132_62) (Frood, 1991; Oates and Taranto, 2001; Cook and Yugovic, 2003).

Some grassland areas dominated by Coast-tussock grass also include species characteristic of (sub-)saline areas, such as Shiny Swamp-mat *Selliera radicans* and Australian Salt-grass *Distichlis distichophylla*. Some of these areas are probably best described as Brackish Grassland (EVC 934). In the more pronounced depressions, the vegetation is probably best described as wetland, as discussed below.

Swamp Scrub

The survey plans all show areas of 'Tea Tree Scrub'. This vegetation is unequivocally identifiable as Swamp Scrub (EVC 53) (Oates and Taranto, 2001). Two large areas (7.3 ha and 1 ha) of mature Swamp Paper-bark remain in Safety Beach, and clearly correspond to areas delineated as 'Tea tree Scrub' by Smythe (undated). Only one of these areas was able to be visited, and was found to be highly modified by weeds. Two of the smaller 'house' blocks surveyed in detail also support remnants of Swamp Scrub (FIS quadrats E03409 and E03410). They contain species typical of Swamp Scrub (such as Swamp Paperbark, Prickly Moses *Acacia verticillata* and Slender Tussock-grass *Poa tenera*), but also a few species more typical of open, grassy wetlands, notably Common Blown Grass *Lachnagrostis filiformis*. This is readily explicable, given that much of the Swamp Paperbark cover has been removed and suppressed by mowing, leaving these swampy areas open to invasion by open wetland species, and

Table 2. Plant Species found at Safety Beach in 2005-6. All names are used according to Ross and Walsh (2003). 'r' indicates taxa rare in Victoria, 'v' vulnerable in Victoria. The lack of a check mark for any species against a given vegetation type show ONLY that the species was not recorded in that type on this survey, NOT that the species would never have occurred there.

Species	Common Name	Grassland	Marsh	Swamp Scrub	Sandy rises
FERNS					
Dennstaedtiaceae					
Pteridium esculentum	Austral Bracken				o
MONOCOTYLEDONS					
Cyperaceae					
Baumea articulata	Jointed Twig-sedge	o	o		
Carex appressa	Tall Sedge	o	o	o	
Carex breviculmis	Common Grass-sedge	o	o		
Eleocharis acuta	Common Spike-sedge	o	o		
Ficinia nodosa	Knobby Club-sedge				o
Gahnia filum	Chaffy Saw-sedge	o	o		
Isolepis cernua var. *platycarpa*	Broad-fruit Club-sedge		o		
Isolepis inundata	Swamp Club-sedge		o		
Isolepis marginata	Little Club-sedge	o	o	o	
Lepidosperma laterale var. *majus*	Variable Sword-sedge			o	
Lepidosperma ?gunnii	Sword Sedge	o			
Schoenus apogon	Common Bog-sedge	o	o	o	
Schoenus tesquorum	Soft Bog-sedge	o	o		
Juncaceae					
Juncus amabilis	Hollow Rush	o		o	
Juncus holoschoenus	Joint-leaf Rush	o		o	
Juncus pallidus	Pale Rush	o		o	
Luzula meridionalis var. *densiflora*	Common Wood-rush	o			
Juncaginaceae					
Triglochin striata	Streaked Arrow-grass		o		
Liliaceae					
Caesia calliantha	Blue Grass-lily	o			
Caesia parvifolia var. *parvifolia*	Pale Grass-lily				o
Dianella brevicaulis	Small-flower Flax-lily	o		o	
Dianella laevis	Smooth Flax-lily			o	o
Dianella revoluta subsp. *revoluta* s.l.	Black-anther Flax-lily	o			
Hypoxis hygrometrica	Golden Weather-glass	o			
Hypoxis vaginata var. *vaginata*	Yellow Star	o			
Tricoryne elatior	Yellow Rush-lily	o			
Orchidaceae					
v *Diuris behrii*	Golden Cowslips	o			
Microtis arenaria	Notched Onion-orchid	o			
Microtis parviflora	Slender Onion-orchid	o			
Microtis unifolia	Common Onion-orchid	o	o	o	
Thelymitra antennifera	Rabbit Ears	o			
Thelymitra pauciflora s.l.	Slender Sun-orchid	o			

Table 2 (cont.)

Species	Common Name	Grassland	Marsh	Swamp Scrub	Sandy rises
Poaceae					
Austrodanthonia caespitosa	Common-Wallaby-grass	o			
Austrodanthonia geniculata	Kneed Wallaby-grass				o
Austrodanthonia laevis	Smooth Wallaby-grass	o			
Austrodanthonia racemosa var. *racemosa*	Slender Wallaby-grass	o		o	
Austrodanthonia setacea var. *setacea*	Bristly Wallaby-grass				o
Austrostipa flavescens	Coast Spear-grass				o
Austrostipa pubinodis	Tall Spear-grass	o			
Austrostipa semibarbata	Fibrous Spear-grass	o			
Distichlis distichophylla	Australian Salt-grass	o			
Elymus scaber	Common Wheat-grass	o			
Eragrostis browuii	Common love-grass	o			
Hemarthria uncinata	Matt Grass	o			
Lachnagrostis filiformis var. 1	Common Blown-grass		o	o	
r *Lachnagrostis punicea* subsp. *punicea*	Purple Blown-grass	o			
Microlaena stipoides	Weeping Grass	o		o	
Notodanthonia semiannularis	Wetland Wallaby-grass	o		o	
Phragmites australis	Common reed		o		
Poa labillardierei	Common Tussock-grass	o		o	
Poa 'poiformis'	Coast Tussock-grass	o	o		
Poa tenera	Slender Tussock-grass			o	
Pentapogon quadrifidus	Five-awned Spear-grass	o			
Themeda triandra	Kangaroo Grass	o			
Xanthorroeaceae					
Lomandra longifolia	Spiny-headed Mat-rush	o		o	o
DICOTYLEDONS					
Aizoaceae					
Carpobrotus sp.	Pigface	o			
Apiaceae					
Centella cordifolia	Pennywort	o			
Eryngium vesiculosum	Prickfoot	o	o		
Asteraceae					
Brachyscome graminea	Grass Brachyscome	o			
Calocephalus lacteus	Milky Beauty-heads	o			
Cassinia aculeata	Common Cassinia	o			
Cassinia longifolia	Shiny Cassinia	o			
Euchiton involucratus s.s.	Star Cudweed	o			
Ozothamnus ferrugineus	Tree Everlasting	o		o	
Pseudognaphalium luteoalbum	Jersey Cudweed	o			
Leptorhynchos tenuifolius	Wiry Buttons	o			
Senecio glomeratus	Annual Fireweed	o			
Solenogyne dominii	Smooth Solenogyne	o			
Convolvulaceae					
Dichondra repens	Kidney Weed	o		o	
Droseraceae					
Drosera peltata subsp. *peltata*	Pale Sundew	o			
Epacridaceae					
Astroloma humifusum	Cranberry Heath	o			

Table 2 (cont.)

Species	Common Name	Grassland	Marsh	Swamp Scrub	Sandy rises
Euphorbiaceae					
Amperea xiphoclada	Broom Spurge				o
Fabaceae					
Bossiaea cinerea	Showy Bossiaea				o
Bossiaea prostrata	Creeping Bossiaea	o			
Kennedia prostrata	Running Postman				o
Viminaria juncea	Golden Spray	o			
Geraniaceae					
Geranium retrorsum s.l.	Grassland Cranesbill	o			
Geranium sp. 2	Variable Cranesbill	o		o	
Goodeniaceae					
Goodenia ovata	Hop Goodenia	o		o	
Selliera radicans	Shiny Swamp-mat	o	o		
Haloragaceae					
Haloragis heterophylla	Varied Raspwort	o	o		
Lythraceae					
Lythrum hyssopifolia	Small Loosestrife	o	o	o	
Mimoscaeae					
Acacia melanoxylon	Blackwood	o		o	
Acacia verticillata	Prickly Moses			o	
Myrtaceae					
Eucalyptus ovata	Swamp Gum				o
Eucalyptus viminalis	Manna Gum				o
Leptospermum laevigatum	Coast Tea-tree	o			o
Leptospermum continentale	Prickly Tea-tree	o			
Melaleuca ericifolia	Swamp Paperbark	o		o	
Onagraceae					
Epilobium billiardierium subsp. *intermedium*	Variable Willow-herb			o	
Oxalidaceae					
Oxalis sp. aff. *exilis* (glabrescent)	Shady Woodsorrel	o		o	
Proteaceae					
Banksia integrifolia	Coast Banksia				o
Ranunculaceae					
Clematis microphylla	Small-leaved Clematis			o	
Rosaceae					
Acaena ovina var. *velutina*	Australian Sheep's Burr	o			
Acaena novae-zelandiae	Bidgee-widgee	o		o	
Rubiaceae					
Asperula conferta	Common Woodruff	o	o		
Opercularia ovata	Broad-leaf Stinkweed	o			
Opercularia varia	Variable Stinkweed				o
Santalaceae					
Exocarpos strictus	Pale-fruit Ballart			o	
Scrophulariaceae					
Gratiola peruviana	Austral Brooklime			o	
Veronica gracilis	Slender Speedwell	o	o	o	
Solanaceae					
Solanum laciniatum	Large Kangaroo Apple				o
ALGAE (incomplete)					
Chara sp.	Stonewort		o		

numerous weeds. Most of the Swamp Scrub is attributable to Swamp Scrub (Freshwater) (EVC 53_61), although some areas of Swamp Scrub (Estuarine) (EVC 53_62) may have occurred near the creek mouths.

Marshes

The survey plans (Nutt, 1841; Anon 1857; Smythe, undated) show areas of treeless wetland, labelled by terms such as 'marshy plain' and 'swampy flat'. Unfortunately, no open wetlands are now preserved in the area. However, numerous wetland plant species occur in several of the deeper depressions within the grassland, and on the road verge of Nepean Hwy (between Marine Drive and Mornington Peninsula Freeway; see Fig. 2). Although the soils and hydrology have been altered greatly since settlement by earthworks, this roadside preserves several flora species which may show something of the character of the wetland vegetation that was once present locally. It is dominated by sedges and rushes (Common Spike-sedge *Elaochaeris acuta*, Jointed Twig-sedge *Baumea articulata*, Streaked Arrow-grass *Triglochin striata*, Common Bog-rush *Schoenus apogon*, Tall Sedge *Carex appressa* and Club Sedges *Isolepis* spp.) and some grass and herb species, including Prickfoot. In standing water, algae of the genus *Chara* are prominent.

Under DSE's current typology (Frood unpublished.), several wetland EVCs probably once occurred in the Safety Beach area. Judging from the known characteristics of the landscape and the little remaining physical evidence, the most common EVC was probably Plains Grassy Wetland (EVC 125). This is a broadly defined EVC with several floristic communities, including Herb-rich Plains Grassy Wetland, which is characterised by many of the herb species still found at Safety Beach (SAC, 1996). This community occurs on the margins of the former Carrum Swamp, which occurred in a landscape very similar to Safety Beach.

Woodlands on sandy rises

Several raised, sandy areas are present at Safety Beach (see Fig. 2), some of which still support a few indigenous plants, including the trees Narrow-leaved Peppermint *Eucalyptus radiata* and Coast Banksia *Banksia integrifolia*, along with Austral Bracken *Pteridium esculentum* and several shrubs, herbs and grasses including Coast Spear-grass *Austrostipa flavescens*, Broom Spurge *Amperea xiphoclada* and Showy Bossiaea *Bossiaea cinerea*. These areas are clearly remnants of either Dampsands Herb-rich Woodland (EVC 3) or Coast Banksia Woodland (EVC 2) (Oates and Taranto, 2001), two EVCs which both occur on near-coastal sandy flats. These vegetation types were probably scattered along the beach and throughout the Safety Beach area, on small patches of sand (FIS Quadrat E03411). The aerial photographs from 1957 clearly show wooded sandy rises scattered across the otherwise almost treeless plain (Fig. 4).

Eucalypt 'woodlands' on heavier soil

In addition to the sites supporting trees on sandy rises, one other treed site occurs on heavier soil (FIS Quadrat E03412). It shares many of the species of the sites described above, but also supports a mix of species characteristic of woodlands across the wider Mornington Peninsula. For example, the lower layer includes Prickly Tea-tree *Leptospermum continentale*, Grey Parrot Pea *Dillwynia cinerascens* and Hedge Wattle *Acacia paradoxa*. The tree layer includes Swamp Gum *Eucalyptus ovata* and Black Wattle *Acacia mearnsii*. This small, isolated site is difficult to assign confidently to an EVC under the current typology, but it clearly supports floristic elements of Grassy Woodland (EVC 175), Swampy Woodland (EVC 937) and Swampy Riparian Woodland (EVC 83). The presence of trees and shrubs at this site, in contrast to the other sites on heavier soils, is possibly due to this site experiencing less severe drought stress in summer. The site is directly adjacent to one of the major drainage channels, giving larger trees direct access to permanent water. Furthermore, the site sits on a slightly raised natural levee, composed of slightly coarser material than the surrounding heavy-soil plain, ameliorating the severity of soil cracking in summer, which otherwise disadvantages the establishment of woody species. The aerial photographs taken in 1957 show other trees clustered along the stream channels (Fig. 5). The

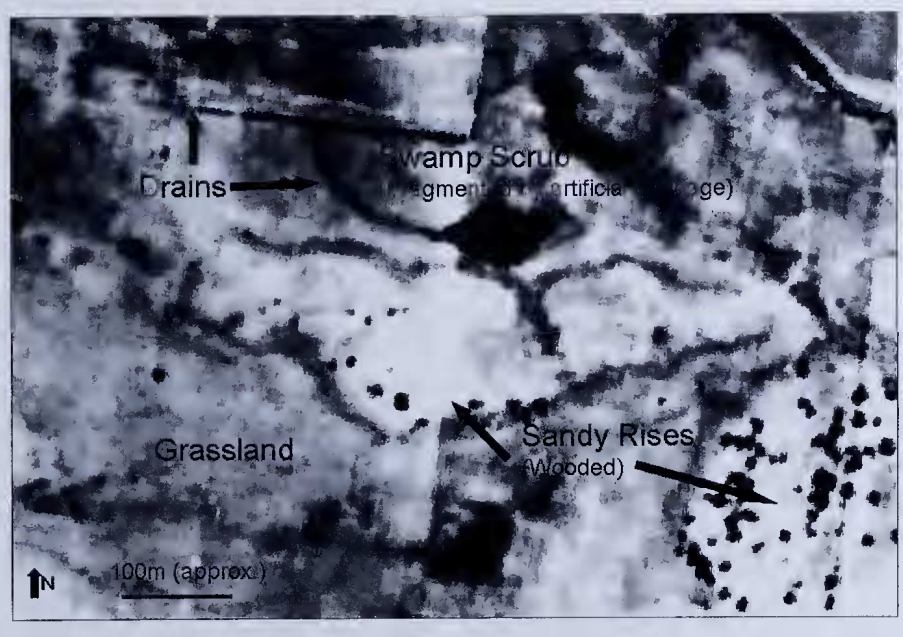

Fig. 4. Grassland interrupted by Sandy Rises and Swamp Scrub, 1957. The area shown is covered by the vegetation map (The lower rectangle on Fig. 2). The area at the top of the photograph is clearly delineated by Smythe (undated) as Swamp Scrub. By 1957, this area had been largely drained.

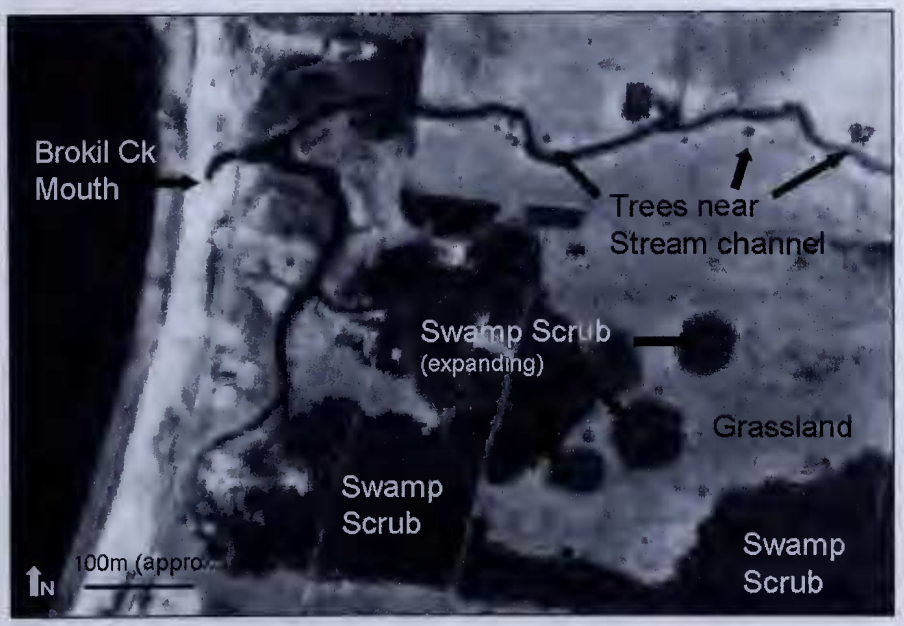

Fig. 5. The mouth of Brokil Creek with associated stream channels, scrub and grassland, 1957. The area shown is covered by the vegetation map (the upper rectangle on Fig. 2). Several patches of Swamp Scrub are apparently expanding. Their circular shape probably results from the radial suckering of the dominant Swamp Paperbark.

additional species recorded at this site have not been recorded in Table 2, since the site is transitional, and includes elements more characteristic of Grassy Woodland (EVC 175), which has not otherwise been investigated in any detail here.

Mapping the past patterns of vegetation at Safety Beach

Fig. 2 presents an attempt to map the former patterns of native vegetation at Safety Beach. The map was created using both current and historical data, and is necessarily 'coarse'. Several 'zones' are represented on the map, each corresponding to the vegetation types already discussed.

Grassland: Most areas mapped as 'grassland' are (almost) treeless on the 1957 photographs, on heavy soils, and in areas marked as 'swampy', 'grassy','fine', or 'open' (and distant from any comments mentioning scrub or trees) on Smythe's map. While these areas can be delineated readily in some areas, in others the precise boundaries of the 'grassland' are difficult to determine. These are often areas where the soil boundaries are now obscure, and Smythe provides no boundary line on his map. These areas only tentatively assigned to 'grassland' are marked with question marks (?) on Fig. 2. The area of 'grassland' was locally between ~300 and 560 hectares.

Swamp Scrub: Areas of Swamp Scrub have been traced directly from Smythe's (undated) map, which clearly delineates this EVC. Some boundaries have been modified slightly with reference to the 1957 aerial photographs.

Marshes: These areas have been traced directly from Smythe's map, with some minor alterations with reference to the 1957 aerial photographs.

Woodlands on Sandy Rises: These areas are not apparent on Smythe's map, presumably because they are relatively small. However, they are clearly visible on the 1957 aerial photographs (Fig. 4), and are often evident today, even in the urban environment.

Eucalypt Woodland on Heavy Soils: This vegetation, discussed above, is NOT MAPPED on Fig. 2, since it was probably of minor extent, along stream channels and associated with Swamp Scrub.

Terrestrial vegetation- various: On the map, this unit is used to account for the vegetation not discussed in this paper. It includes areas labelled by Smythe or Nutt (1841) as 'heathy plain', 'stringybark', or 'thickly wooded oak, scrubby and rushy land'. These areas still support patches of Damp Heathy Woodland (EVC 793), Grassy Woodland (EVC 175) and Damp Heathland (EVC 710) (Sinclair *et al.*, 2005).

Discussion

Safety Beach in context – Grasslands in south-eastern Victoria

When Victoria was colonised, a large part of the state's lowlands was covered by Plains Grassland (EVC 132). This vegetation is best documented for the basalt plains of Western Victoria, where detailed botanical and ecological studies have been undertaken over a number of decades (e.g. Sutton 1916-1917; Patton, 1935; Willis 1964; Stuwe and Parsons, 1977; Lunt 1990; Morgan and Rollason, 1995). Large areas of grassland also occurred in northern Victoria (Carter *et al.*, 2003; Kirkpatrick *et al.*, 1995). These grasslands were important in the history of Victorian agriculture and settlement, and have long been well known (Howitt, 1855; Powell, 1970).

The smaller grasslands of lowland eastern Victoria, in contrast, are less well known, with relatively few studies into their floristic composition, distribution or ecology (Lunt 1997; Cook and Yugovic, 2003; Yugovic and Mitchell, 2006). The historical evidence for their existence is fragmentary, and very little physical evidence of them remains. For example, Cook and Yugovic's recent work (2003) on the former Clyde-Tooradin grassland was partially concerned with simply demonstrating its existence, after all memory or evidence was apparently lost.

Grasslands occur under conditions favouring grasses, but precluding the establishment or survival of shrubs and trees. The combination of factors creating these conditions differ from area to area, and are sometimes difficult to interpret. In western and northern Victoria, it has long

been recognised that the formation of grasslands is promoted by heavy clay soils in combination with relatively low rainfall, which make water stress too severe for the establishment of trees. In winter, the heavy soil swells, while in summer it opens into deep cracks that cause severe drought-stress (Sutton, 1916-17; Patton, 1930, 1935, Willis 1964). Lunt (1997) also suggested a role for drought-stress in preventing tree growth on the (now-extinct) grasslands around Sale, most of which occurred in a rain-shadow area. In their discussion of the Clyde-Tooradin grassland, which exists in an area of relatively higher rainfall, Cook and Yugovic (2003) suggested that burning by aboriginal people was necessary to maintain this area as an open grassland, to prevent the encroachment of the adjacent Swamp Paperbark. They also suggested that other low-lying, swampy places in southern Victoria were also regularly burnt before colonisation, leading to the maintenance of a number of small grasslands in lowland Gippsland, including Brokil Ck at Safety Beach. These comments of Cook and Yugovic (2003) encouraged on-ground investigation at Safety Beach.

Timber on the grasslands

The 'good grass country' on the flat shown by Smythe (undated) is described as being 'timbered with lightwood'. Lightwood *Acacia implexa* generally occurs in dry sites with shallow or rocky soils (Costermans 1983, Entwisle *et al.*, 1996) and does not usually occur in seasonally waterlogged soils like those at Safety Beach. Smythe's reference to it in this environment requires explanation. No Lightwoods were observed in Safety Beach during field-work for this paper, and there are no records of Lightwood from this area (when all databases available on the FIS, including herbarium data, are searched). Other woody species (including Coast Banksia *Banksia integrifolia* and Blackwood *Acacia melanoxylon*) remain in suburban Safety Beach, so that if Lightwood ever occurred here, it has been entirely and preferentially removed. Together, these observations suggest that Lightwood may never have occurred at Safety Beach, and that Smythe's usage of this name differs from the present usage. It is probable that Smythe was instead referring to the very similar Blackwood, which still occurs scattered in Safety Beach, and which tolerates inundation and drought. This alternate usage of the name 'Lightwood' also appears in other reports of the 1800s, according to Yugovic and Mitchell (2006).

Smythe's use of the word 'timbered' is also worth discussing. Was this area a treeless plain, or a woodland? The historic plans and the floristic evidence suggests that the trees were present but sparse (and may have occurred 'in mosaic' with treeless areas, depending on subtle soil changes, see below). Certain species (such as Milky Beauty-heads and Prickfoot) are grassland/grassy-wetland-specific and rarely occur on sites with an appreciable canopy (pers. obs.). Their presence strongly suggests that these sites have long supported very open, grassy vegetation. The Blackwoods noted probably occurred with several other species of small tree and shrub, possibly including Drooping sheoak *Allocasuarina verticillata*, Black Wattle *Acacia mearnsii*, and Golden Spray *Viminaria juncea* (the latter species only around depressions and wetlands), all of which are today present in Safety Beach, probably as remnant populations. It is worth noting that the term 'Plains Grassland' is regularly applied to partially treed areas across Victoria.

Factors influencing vegetation patterning at Safety Beach

Cook and Yugovic (2003) suggested that fire was important in maintaining the boundary between open plains and patches of suckering Swamp Paperbark at Clyde-Tooradin. A similar explanation has been offered to explain the maintenance of other grasslands in South Gippsland (Yugovic and Mitchell, 2006). This was based on the observation that the grassland occurred under the same conditions as the adjacent wet Swamp Scrub, making water-stress an apparently untenable argument for the treelessness of such grassland. A few patches of Swamp Scrub at Safety Beach apparently expanded between the 19th century (Smythe, undated) and 1957 (Fig. 5), supporting the idea that fire management once

played a role in maintaining some grassland boundaries. Cook and Yugovic (2003) also noted the obvious benefit for the indigenous people in keeping the area open and free from scrub. At Safety Beach, the benefit to be gained by Aboriginal people from keeping the area open would have been similarly great. Plant and animal foods would be accessed more easily (and may have been more plentiful), and an open plain would have allowed easy access to the beach, which is otherwise difficult locally because of the steep cliffs of Mt Martha and Arthurs Seat. Unfortunately, there is no reliable record of Aboriginal burning practices detailed enough to confirm these ideas.

Several lines of evidence also suggest that fire was not necessarily the only (or even the major) factor maintaining the open grassy vegetation at Safety Beach. Firstly, the former presence of Blackwood suggests that fire intensity was probably lower than that needed to suppress vigorous, suckering Swamp Paperbark. Secondly, most patches of Swamp Scrub at Safety Beach corresponded to drainage lines and depressions (unlike Clyde-Tooradin or Koo-Wee-Rup), and some patches have maintained essentially the same boundaries for about 150 years (as deduced from Smythe (undated), the old aerial photographs (1957) and current observations), suggesting that Swamp Scrub was often restricted by relief, not predominantly by fire (although relief may influence fire behaviour).

Small changes in local relief and soil-type were probably of key importance in determining patterns of treelessness at Safety Beach, through their interactions with water availability. Drainage lines were presumably best able to support Swamp Paperbark and Swamp Gum because they remained moist most of the year, while the slightly higher plains would have been moist in winter, but probably dry enough in summer to crack and disadvantage woody plants, as on the western and northern plains (Sutton, 1916-17; Patton, 1930, 1935, Willis 1964). In these areas today, large, deep soil cracks several centimetres wide can be observed in summer; although these must be interpreted with caution, since the hydrology has probably changed markedly since settlement. It is important to note that soil type and fire history are not mutually exclusive explanations for patterns of treelessness, and that these factors may interact (for example, drier areas of relatively heavy soil may be less rapidly colonised by Swamp Paperbark, and these areas would be the most naturally promising areas to maintain as open plains via burning). While the historic vegetation boundaries reflect physical differences in soil texture and hydrology they may have been further accentuated through the judicious human use of fire.

Small depressions in the grassland would have supported pools in winter. These probably suffered minor or severe drought stress in summer, depending on their depth and soil structure. These areas presumably contained various types of open 'marshes' now referred to as Plains Grassy Wetlands. Small sandy rises provided growing conditions that are different again, the sandy substrate being well-drained and non-cracking. As noted above, these areas supported Damp-sands Herb-rich Woodland (EVC 3) and Coast Banksia Woodland (EVC 2).

Salinity is also undoubtedly a factor influencing vegetation patterns at Safety Beach, both through salt spray and through the influence of saline ground-water and (in isolated areas) tidal inundation. Again, relief plays a major role in determining whether plants are exposed to salinity. Depressions in areas with saline ground-water, or the banks of the salty creeks, expose plants to salt stress, and would have carried vegetation referrable to Brackish Grassland (EVC 934). In this way, the coastal flat at Safety Beach resembles an estuary, where patterns of saltmarsh, wetland and grassland are intricately patterned according to elevation. It is possible that small patches of typically estuarine vegetation (such as Coastal Saltmarsh (EVC 9), Estuarine Wetland (EVC 10), Estuarine Flats Grassland (EVC 914), Swamp Scrub (Estuarine) (EVC 53_62) and Brackish Sedgeland (EVC 13), Oates and Taranto, 2001; Frood unpubl.) occurred at the mouths of the small salty creeks, although there is no physical evidence of any such communities now. Port Phillip has lost many of its small 'estuarine' creek mouths since settlement, with few (e.g. Balcombe Creek.) surviving.

A note on plant identification

The dominant Tussock-grass was identified here as Coast Tussock-grass *Poa poiformis*. In his description of Plains Grassland (South Gippsland) Frood (1991) notes

> The form of *Poa labillardierei* is of comparable morphology (viz. Compact tussock with bluish inrolled foliage which is sometimes quite prickly, and superficially resembling *P. poiformis*) to the form which occurs on black soils of the western volcanics (e.g. Merri Creek grasslands and Skipton area).

Several quadrats taken by others at Carrum in open, grassy vegetation resembling the moist grasslands of Safety Beach record the dominant grass as *Poa labillardierei* var. (Basalt Plains) (FIS quadrats N02206-N02209). This informal varietal name includes several entities with stiff, bluish, prickly leaves (N. Walsh, pers. comm.). Given the ecological similarities between all these sites, it is tempting to conclude that essentially identical plants dominate at all sites, but are difficult to determine using the current taxonomy, and which are treated differently by different observers. Such difficulty in placing plants into described taxa is not unusual or unexpected in *Poa*, which has long been recognised as a genus with much variation that is difficult to deal with taxonomically (Vickery, 1970).

Biological significance and prospects for conservation

The vegetation communities at Safety Beach are highly significant, in terms of their Bioregional Conservation Status (www.dse.vic.gov.au). Plains Grassland (South Gippsland) is endangered throughout its range, and is also listed as endangered under the *Flora and Fauna Guarantee Act* 1988 (SAC, 1994). Brackish Grassland has not been mapped anywhere else in the Port Philip area. However, it is understood that it once occurred near the mouth of the Yarra and possibly at Phillip Island (Oates and Taranto, 2001). It is considered rare in the Gippsland Plain Bioregion. Swamp Scrub, while still relatively abundant in some areas of the Mornington Peninsula, is considered endangered in the Gippsland Plain Bioregion. Several plant taxa are also considered worthy of note, given their conservation status (Ross and Walsh, 2003).

Golden Cowslips *Diuris behrii* is considered vulnerable in Victoria. This orchid has not previously been recorded on the Mornington Peninsula. At Safety Beach, only three plants were noted (FIS quadrat E03404).

Purple Blown-grass *Lachnagrostis punicea* subsp. *punicea* is considered rare in Victoria and Australia. A single previous record of this species exists on the Mornington Peninsula, from Pt Leo (1996, FIS T17503). It remains on many of the remnant patches at Safety Beach.

Several other species should be considered regionally or locally significant, being relatively rarely encountered on the Mornington Peninsula (pers. obs.), including Grass Brachyscome *Brachyscome graminea*, Milky Beauty-heads *Calocephalus lacteus*, Prickfoot, Varied Raspwort *Haloragis heterophylla*, Rabbit Ears *Thelymitra antennifera*, and Common Woodruff *Asperula conferta*.

Despite these significant biological features, the prospects for conserving grassland at Safety Beach are poor. All of the sites described here are on unreserved urban blocks that will probably be developed in accordance with their current residential zoning. One site was destroyed during the preparation of this report. Due to the small size of the properties (<0.4 ha), Victorian laws regulating removal and offsetting of native vegetation do not apply. Since the sites do not typically contain woody vegetation, council laws relating to removal or lopping of trees do not apply.

Aside from clearing, the major threat to the remaining native vegetation at Safety Beach is weed invasion. Most sites are already severely invaded by numerous weeds. The most serious weeds are the grasses Sweet Vernal-grass *Anthoxanthum odoratum*, Paspalum *Paspalum dilatatum*, Kikuyu *Pennisetum clandestinum*, Yorkshire Fog *Holcus lanatus*, Tall Fescue *Festuca arundinacea*, Rat-tail Grass *Sporobolus africanus*, Canary Grass *Phalaris* spp. and Buffalo Grass *Stenotaphrum secundatum*. As the focus of this paper was the former vegetation of this area, weed species are not listed in Table 2; however, weeds are fully recorded in the quadrat data held by the author and on the FIS.

Several very small areas of land managed by local government exist in the area, which would once have supported native grasslands. Although re-creating native grasslands is apparently near-impossible, representative plants from the local grasslands could be used for revegetation. If weeds were adequately controlled, and several of the more showy species planted (e.g. Milky Beauty-heads), such sites may be able to effectively display – albeit as a somewhat artificial exhibit – some of the original character of Safety Beach.

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Use by birds and mammals of habitats of different complexity in remnant and revegetated sites in the Wannon Catchment, Western Victoria

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Abstract
Extensive land clearing in western Victoria has lead to land degradation, loss of natural habitat and poor water quality. Tree planting has been used to combat these problems and improve biodiversity, but whether these programs are meeting their nature conservation objectives is equivocal. Here we examined the presence of birds and mammals in 12 revegetated sites of different ages and habitat complexity and four remnant habitat sites. We found remnant sites had the greatest abundance in species richness of both birds and mammals, and that use of revegetated sites increased as the sites aged and became more structurally complex. (*The Victorian Naturalist* **124** (3), 2007, 149-156)

Introduction

Land clearing has contributed to degradation of land and water resources, increased greenhouse gases and the decline of biodiversity. Soils are especially affected by clearing and over-use, with acidity, erosion, salinity and fertility loss lowering agricultural production (Gretton and Salma 1996). Clearing has also changed landscapes, often with few remaining patches of vegetation present in a larger matrix of crops or pasture grasses. Such patchiness may limit movements of fauna, thus reducing genetic diversity (Merriam and Saunders 1993; Deacon and Mac Nally 1998). Habitat destruction and fragmentation is considered a leading cause of the decline of biodiversity in Australia (Hobbs and Hopkins 1990; Recher 1993).

Revegetation is one strategy used to reduce these deleterious effects of land clearing. However, most revegetated patches are small, fragmented and linear with high edge to area ratios. Their value (and those of small and often linear remnants) in terms of mammal and bird conservation has only recently received attention, and the conclusions have been equivocal (Bennett 1990; Lynch and Saunders 1991; Hobbs 1993; Crome *et al.* 1994; Downes *et al.* 1997; Deacon and Mac Nally 1998; Rossi 2001). Recent studies of this kind that have been undertaken in south-eastern Australia have included Ryan (2000), Rossi (2003) and Loyn (2005).